San Francisco Bay Area Wetlands Restoration Program
Wetlands Monitoring Group

Letter of Review
August 10, 2005

Sonoma Baylands Restoration Project Monitoring Plan
Sonoma County, California

IMPORTANT NOTICE: Please note that project review by the Wetlands Monitoring Group monitoring plan review team does not constitute an endorsement of a project nor does it constitute a step in the regulatory and/or permitting process. Project proponents are free to pose questions to the monitoring plan review team at their discretion. The monitoring plan review team does not intend to reach consensus in all of its feedback and dissenting opinions are included as expressed. All feedback is suggestive and non-obligatory; project proponents are not required to incorporate any or all of the feedback into their project.

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1. Project Team:

a. Project Proponent(s): California State Coastal Conservancy, Sonoma Land Trust, and U.S. Army Corps of Engineers

b. Project Presenter to Design Review Group: Phyllis Faber, Jeremy Lowe, and Phil Williams (Phillip Williams and Associates)

2. Wetlands Monitoring Group and Monitoring Plan Review Team:

a. Dates Review Team met to discuss the project: The Sonoma Baylands Restoration Project Monitoring Plan monitoring plan review team featured the first project presentation on May 2, 2005. Following the presentation, the Team discussed the project and inquired about further information.

b. Review Team: **John Callaway –** Wetland plant and sediment ecology (University of San Francisco), **Josh Collins –** Geomorphology (San Francisco Estuary Institute), **Tom Kucera –** Wildlife ecology (UC Berkeley), **Phillip Lebednik –** Ecology and wetlands function (LFR Levine-Fricke, Inc.), **Roger Leventhal –** Engineering and wetland hydrology/hydraulics (FarWest Engineering), **Nadav Nur –** Wildlife ecology (PRBO Conservation Science), and **Stuart Siegel –** Wetlands restoration design and function (Wetlands and Water Resources, Inc.)

Six monitoring plan review team members were in attendance at the May 2, 2005 meeting; Josh Collins submitted written comments following the meeting date.

c. Non-Review Team Meeting Attendees: (05/02/05) Bob Batha (San Francisco Bay Conservation and Development Commission), Peter Baye (Independent biologist), Andree Breaux (San Francisco Bay Regional Water Quality Control Board and Wetlands Monitoring Group chair), Rachel Bonnefil (Ecologist), John Brosnan (Sonoma Land Trust), Ann Buell (State Coastal Conservancy), Phyllis Faber (Phillip Williams and Associates), Naomi Feger (San Francisco Bay Regional Water Quality Control Board), Tom Gandesbery (State Coastal Conservancy), Brenda Goeden (San Francisco Bay Conservation and Development Commission), Steve Goldbeck (San Francisco Bay Conservation and Development Commission), Cay Goode (U.S. Fish and Wildlife Service), Amy Hutzel (State Coastal Conservancy), Eric Joliffe (U.S. Army Corps of Engineers), Marilyn Latta (Save San Francisco Bay Association), Jeremy Lowe (Phillip Williams and Associates), Jim McGrath (Port of Oakland), Mike Monroe (U.S. Environmental Protection Agency), Anitra Pawley (The Bay Institute), Barbara Salzman (Marin Audubon Society), Brendan Thompson (Friends of the San Francisco Estuary), Carl Wilcox (California Department of Fish and Game), Phil Williams (Phillip Williams and Associates)

d. Letter of Review development: John Brosnan, editor (Sonoma Land Trust), Brendan Thompson, recorder (Friends of the San Francisco Estuary)

3. Review Process:

a. Project background information: At 289 acres in size, the Sonoma Baylands Tidal Restoration Project was the largest planned tidal wetlands restoration project at the time when construction was completed in 1996. The State Coastal Conservancy provided money to the Sonoma Land Trust to develop the design, and PWA created the rigorous design. Only $58,000 was budgeted for the planning. Peninsulas with heights of +5 NGVD were employed to break wave fetch. The project included seasonal wetlands mitigation; that area has not been monitored since completion. After construction, elevations were one foot lower than they were designed to be. This project was the first to attempt to control elevations and there was no post-construction survey.

The lack of widening the tidal channels across the outboard centennial marsh that connect to the levee breaches effectively put an 8-year lag on the tidal marsh evolution. The inlet channels are now 50 feet across. In the main unit, 2003 saw a two-foot tidal range, and 2004 saw almost five feet of tidal range. A sill that impedes the flow of water at the main unit is still experiencing very limited erosion. The temporal lag is due to the presence of the sill located near the breach inlets. In the pilot unit, the inundation regime is similar to that of San Pablo Bay. The pilot unit's evolution from 2003-2004 was substantial. There has been a fair amount of peninsular erosion.

Eric Joliffe noted the US ACOE is paying 75% of the costs of monitoring the Sonoma Baylands site, and the CA Coastal Conservancy is responsible for the other 25%. Usually the ACOE only pays 2-3% of construction costs (3% is actually considered high), but for this project it has been closer to 10% and they are only half way through the monitoring program.

b. Assistance requested by project sponsor:

Phyllis Faber, Jeremy Lowe, and Phil Williams, representing the project's planning team, presented an overview of the restoration project, the monitoring plan, and data collection and analysis to date. The project team sought input specifically on the following:

Phil Williams stated that some objectives were not being met

Should the current trajectory be re-established (remediation), OR
Should the conceptual vision be revisited?

Andree Breaux submitted questions to the team at this point

1. What are the appropriate adaptive management mechanisms? Site evolution has been slower than anticipated, but after PWA presentation of biological data, might we conclude that the slow evolution has actually benefited biological species? Are there any long-term negative impacts from slow development? Do we actually want to build in some of these types of slow-evolving sites with dredge sediment because of their high ecological value, or should we plan for more such sites to fill in on their own without dredged sediment?

2. What are the lessons for regulation dealing especially with performance criteria for these projects – should some be omitted or others added? For example, regarding vegetation performance criteria, is establishment within five years and 65% cover by Year 20 appropriate? Should water quality be measured in areas with less circulation? Should invertebrates and peninsulas be monitored? Are resistivity staffs useful for measuring sedimentation? Regulatory agencies need to know what the minimum criteria s are to determine project success. Given the slower than expected pace of Sonoma Baylands in reaching some of the performance criteria, we should probably encourage restoration projects to give themselves longer timelines. Has funding been adequate for development of annual reports and presentations?

3. What are the lessons for design of future marsh projects: Was it prudent at the Sonoma Baylands site to avoid California clapper rail habitat? In terms of phasing and the use of dredge materials for wetland restoration projects, do we want to speed up site development, slow it down, or keep it at about the same pace as Sonoma Baylands to promote open water habitat for birds?

Phil Williams — Three unanticipated Site Specific conditions

1. The channel took 8-9 years to erode and not less than 5 years. The hypothesis is that the high elevation of the outboard marsh did not allow for the spring tide to inundate the marsh, and thus reduced the scouring effect

2. The presence of the sills. The sills were unexpected impediments to scouring— the site was graded to accommodate predicted maximum scouring depths— scouring was not expected to occur through material other than through the introduced dredge material

It is PWA hypothesis that the sills will erode naturally; is this a reasonable hypothesis? Does the monitoring plan capture the sill evolution?

At what point do we know the PWA hypothesis is correct or decide that sill removal is necessary?

3. Current elevation of the peninsulas is higher than anticipated; is this a problem? At what point is it a problem? Using monitoring program, at what point can it be decided that sill height is a problem requiring remedial action?

Phil Williams – Unanticipated development and Peninsulas

--There are slough channels forming between the levee and two of the peninsulas.

--The Monitoring Plan is an opportunity to inform on the function of the peninsulas. Are they fulfilling their intended roles of aiding the accretion and colonization process?

--Are they impacting internal channel formation?

--Monitoring of the seasonal wetlands/ponded areas would be beneficial

Tom Kucera suggested that "adaptive management" was not used correctly, and Phil Williams said "remedial actions" could be used instead.

Nadav Nur suggested discussing performance criteria and what data were needed to support these criteria; what new data are needed.

c. Materials reviewed:

- *Sonoma Baylands Wetlands Demonstration Project Monitoring Plan,* San Francisco District U.S. Army Corps of Engineers and California Coastal Conservancy, October 1996
- Draft Memorandum from Phillip Williams and Associates to Eric Joliffe, U.S. Army Corps of Engineers, regarding Analysis of Sonoma Baylands Evolution from 1996 to 2003 and Recommendations for Management Actions, August 12, 2004
- Project presentation to monitoring plan review team, May 2, 2005

4. Monitoring Plan Review Team Findings and Comments:

The monitoring plan review team shared numerous comments and all feedback is captured in this section. The team does not intend to reach consensus in all of its feedback and dissenting opinions are included as appropriate.

The following represents the professional opinions of the monitoring plan review team members. These opinions are provided for the benefit of the project proponent in direct

response to those questions posed by the proponent. The project proponent is in no way obliged to incorporate any or all of the feedback herein into his project design.

a. Issues Addressed by the Review Team, Discussion and Findings:

The monitoring plan review team providing feedback on the questions posed. Responses have been generally summarized into the following categories: (1) Additional Data and Analysis Needs, (2) Performance Criteria, (3) Peninsulas, (4) Sills, (5) Experimental Approaches, and (6) Comments from meeting attendees (meeting participants who were not members of the review team.

1. Additional Data and Analysis Needs

John Callaway's comments

Invertebrates are probably a lower priority

Josh Collins' comments

The performance criteria can't be ignored. But the essential parameters for site-specific monitoring will be vegetation in plan view and channel density, since they drive local services at the habitat scale, which is where agencies are focused. Protocols exist for both @ http://www.wrmp.org/documents.html#protocols. On-site sedimentation can also be measured, but vegetation and channel density integrate across elevation change, and thus reflect sedimentation. Beyond that, the main physical drivers will be water supply (tidal range), salinity, and suspended sediment supply. The main biological driver will probably be predation. These should be monitored as stressors or drivers inside and outside the site, forever if possible. Predation can be difficult and expensive to track. We ought to think hard about how to monitor predation in a cost-effective way. If we were talking about ambient monitoring, rather than site-specific monitoring, then Josh suggested always including sedimentation rate.

Basic biological monitoring should be restricted to veg in plan view except to meet performance criteria, which may require monitoring birds, small mammals, etc. In such cases, the target species should be residential, or at least breeding on site, so that their condition can be related to on-site processes. If not required by the permit, then targeting animal populations for monitoring at the site might be justified as part of a regional ambient monitoring program for the target species, but not for the site itself.

Monitoring wildlife prey or food webs is most easily justified to explain problems and translate the explanations into corrective actions. So, if clapper rails have to be monitored because the permit says so, and the data indicate a problem (e.g., no rails or the rate of habitation is unacceptably slow), then a variety of possible causes, including predation, food resources, contamination, etc., might be investigated through targeted research. But Josh suggested not getting into that level of detail about the system unless a problem is encountered, where the problem is defined by the managers and scientists together.

Tom Kucera's comments

Terrestrial vertebrates are not being monitored; given that the original objectives of the project were to restore a tidal salt marsh community and to establish habitat for endangered species, he felt there should be vertebrate data included in the report. Undesirable predatory mammals should be clearly defined and monitored. How do you know there aren't SMHM present if you aren't monitoring for them? How do you know they weren't living in the patch of pickleweed that died off? It is essential to have data indicating when and what animals appear in the community to know if the objectives of the project are being met. Just looking at vegetation is insufficient to evaluate this project's success.

Tom noted some biology will surely follow physical engineering, but whether it is the biology we want is unknowable without monitoring. It seems that although the biology is usually the driving force for many restorations, it is the biology, and especially the vertebrate biology, that gets omitted or deemphasized in project operations and monitoring.

Tom strongly recommended standardized photo plots to monitor the physical and botanical development of this and any other restoration site over time. Taken periodically (several times per year?), this is an easy and relatively cheap monitoring technique.

Tom felt much more needed to be learned about the presence of wildlife at the site.

Tom asked how well understood the benthic community is and cautions against indirect methods as being unreliable.

Phil Lebednik's comments

Phil called for a better coupling of biological monitoring with physical processes. Phil suggests establishing thresholds where a certain site condition triggers a certain type of monitoring action; this will be economically more efficient. He also suggested coupling of biological monitoring with water quality monitoring, such as inexpensive salinity measurements. In addition, certain parameters included in initial monitoring events may be either eliminated or reduced once the parameter approaches an equilibrium value. Then monitoring resources can be re-allocated to other parameters of importance as the restoration trajectory matures.

Comments on 2004 Analysis Report, Section 5.2: Recommendations for Revisions to Monitoring Plan (or Future Monitoring Plans for other sites):

1. Monitoring internal cross-section to track internal Sedimentation: Is there any way of determining what the subsidence is there, and how would you be able to differentiate that from sedimentation?

2. Monitoring the tidal regime simultaneously w/ Petaluma RR Bridge: Season is critical for monitoring (equinoctial or solsticial tide, wet or dry season)

3. Aerial photographs to quantify vegetation coverage require ground-truthing.

4. One vegetation transect per year to track elevations and vegetation colonization is not sufficient.

5. Discontinue benthic surveys, but continue annual bird and fish surveys; no data was presented on any of these, and why not? What was the rationale?

Phil would rather see fewer things done well than more things done poorly that you can't draw conclusions from. He suggested that the proponents develop a comprehensive list of conceptual monitoring protocols, prioritize the list and finally select the highest priority items for detailed quantitative or semi-quantitative implementation. Among the selection criteria might be permit-requirements, usefulness of results and cost effectiveness. The remaining protocols that are deemed to be important may then be addressed using qualitative (and low cost) approaches. If limited monitoring resources are distributed across too many parameters, the results will be essentially qualitative anyway, so there is little justification for spending resources to dress them up as if they were more robust than they inherently are.

Identify the inundation tolerance for pickleweed; Jeremy Lowe said that this would be incorporated later.

A better handle is needed on the site processes. There is an uncertainty as to why things have happened the way they have; data is needed to answer this question. Low confidence with current data doesn't allow generalizations to be made about other sites. This is a critical issue if any lessons are to be learned that would help guide future restoration efforts.

Re: Benthic Invertebrate Survey, why this is a topic for discussion given that there aren't any biological criteria for benthic invertebrates?

Roger Leventhal's comments

Roger recommended that as the monitoring proceeds, the data on internal channel formation needs to be presented in quantifiable geomorphic parameters such as channel sinuosity, density, order number etc. in order for someone to review the data. No such data presented.

Nadav Nur's comments

Comparing the inboard marsh to the outboard marsh is not appropriate; it is better to compare to desired conditions in other marshes, using more than one reference site. There is more current data available than was available 9 years ago. Additionally, looking at older and newer restoration marshes will help with determining interim targets. Shorebird density is reported higher at project site than, at reference site, which is inappropriate performance criteria—a fully vegetated mature marsh may have lower shorebird density than an immature forming marsh with a lot of standing water. Focus on collecting data on species that use the site.

Bird diversity, in addition to plant diversity, is not mentioned in the report. He suggests having breeding surveys for birds, as biological data is much more worthwhile than data enumerating appearances.

Nadav noted the importance of collecting data in a way that would be comparable across studies, that way useful conclusions could be made after comparing projects. Nadav suggests collecting standardized data and encouraging protocols to make the data useful. Several peer-reviewed protocols are available from SFEI's webpage under the Wetland Regional Monitoring Program.

Invertebrate sampling should be continued and analysis of all data collected should be presented.

Birds where prey is the limiting factor, you would conduct monitoring of that bird population, and then monitor for other birds where predation or breeding is the limiting factor.

Inundation duration is significant.

The 90% significance level in the monitoring plan indicates that with less robust data comes the chance for a higher level of success.

Stuart Siegel's comments

Stuart noted the critical open question regarding the effectiveness of the wind-wave fetch peninsulas in protecting the inboard levee against erosion, promoting sedimentation, and guiding channel formation. He noted that with the site now largely draining at low tide due to the outboard channel enlargement, the opportunity now exists to collect high-resolution aerial topographic data for the entire site and use these data to evaluate peninsula effectiveness. He also noted that it is critical to define *in advance of the new aerial imagery* the locations of expected effect of the peninsulas, in influencing sedimentation and channel formation, using whatever information informs the PWA conceptual model about these peninsulas and using the local BAAQMD wind data from the station at the corner of Lakeville Highway and Highway 37 (with a discussion of how prior available wind data compares to these more recent data). He emphasizes the importance of advance prediction so as to avoid adjusting the expectations to meet the data and thereby declaring success. These topographic data should also be used to delineate the evolving channel network, and the data should be repeated roughly every two years until rates of change slow to warrant reduced frequency monitoring.

Since no monitoring of the seasonal wetlands created between the inboard levee and railroad berm has taken place, and those wetlands ostensibly were mitigation for seasonal wetlands lost on the site, perhaps it might be beneficial to conduct some monitoring, such as for vegetation, bird use, other wildlife use, and/or hydrologic function?

From what we've seen, the monitoring plan captures sill evolution in terms of a longitudinal profile but it does not characterize the nature of the sill nor does it monitor lateral extent.

Stuart recommended sampling to determine composition and origin of the sill – is it dredged sediment or the underlying farm field? Low-tide topography may yield data as well on the sill, if the site drains low enough and the photo is timed to maximize spring low tide conditions. In this context, also important to know local lag time between tides inside and outside site so can time photo correctly with predicted tides; this is a very critical lesson to be learned here, particularly for Hamilton.

In response to Andree Breaux's question about site evolution timing, use of dredged material, and which species benefit, Stuart noted dredged material reuse ideally speeds the evolutionary process, which is certainly the case in low sediment supply locations. Where sediment supplies are large, the tradeoff is one of delayed breaching to allow dredged material reuse. The analysis necessary to evaluate that tradeoff involves predicting natural sedimentation rates, the rate of dredged material delivery, and resolution of issues such as channel network formation (erosion into placed sediments), sill formation, and water management and its effect on sediment properties between placement and breaching. The analysis also must examine ecological goals and their relationship to site evolutionary trajectories – clapper rail habitat benefits from rapid evolution, shorebird and waterfowl habitats benefit from delayed evolution; both are laudable goals, just different. Sonoma Baylands sought clapper rail habitat which has been delayed in its formation due to conditions at the site. Sonoma Baylands did not seek shorebird and waterfowl habitat but it has had it for many years now and will continue to have it for several years to come. There is clear understanding of the need for additional clapper rail habitat, so efforts at Sonoma Baylands to promote progress toward its original goals would make the most sense, whereas allowing it to linger as shorebird and waterfowl habitat would make less sense. One of the lessons learned here is to decide *a priori* what these goals should be in the context of what any given restoration site can reasonably achieve and in a more regional context – are we using a rare resource (diked baylands) to create a more or less common resource (shorebird and waterfowl habitat or clapper rail habitat)?

If benthic invertebrate information is collected, Stuart suggests using air photos to survey bat rays, which indicate presence of benthic invertebrates. These photos could be concurrent with low-tide imagery for topography.

2. Performance Criteria

John Callaway's comments

John suggested there should be some minimal level of monitoring across all sites, but that much of what is monitored will depend on the goals of a project (as well as the perceived challenges). As Tom Kucera emphasized at the meeting, we need to have clear hypotheses that we are going to test at a site (especially for the large sites like Sonoma Baylands)--these hypotheses will drive the monitoring and will help to really build on existing knowledge in an adaptive framework.

There were preliminary targets, and 20-year targets, but no guidance for the in-between periods. John felt it would be good to identify more specific and interim targets, as well as establish thresholds that define a point to take action. These sorts of specifics for criteria

and time periods are necessary for any adaptive approach (as with the hypotheses about sills above).

John suggests using something in addition to percent plant cover as a success criterion, such as species diversity.

Josh Collins' comments.

This is a policy question as much as a technical question. All habitat will provide some benefit. The existing (emerging) approach seems fine: recognize that the ecological nature of a site evolves through a predictable succession of habitat types; establish desired levels of specific ecological service for each successional sere (science informing policy about what is possible and appropriate), track progress relative to a network of reference places (science), and then make the tough decisions about whether or not the direction and slope of the trajectory is satisfactory (science informing policy). But what is good enough is ultimately a policy decision.

Performance targets should be established with input from science, but they should also reflect public expectations. They must be changeable based on monitoring relative to ambient or reference condition, with more frequent joint review by managers and scientists.

The approach ought to have meetings such as this of managers and technical people more often to review and interpret monitoring data. This would allow for more rapid response to changing conditions or surprises, plus a broader understanding of the situation as it evolves.

Tom Kucera's comments

Tom noted that the slower-than-predicted development of the salt marsh has benefited neither the "salt marsh community" in general nor the two species identified in the original objectives as the primary beneficiaries of and major reasons for the project to begin with. With any activity, some species benefit, others lose. It is the job of management to design things to favor a particular outcome, in this case, 1) the salt marsh community, and 2) clapper rails and salt marsh harvest mice. This apparently has not happened yet, and until it does, declaring victory is premature.

Additional management actions may or may not produce a desirable outcome, but unless they are done in a systematic, explicitly hypothesis-testing manner, they are unlikely to produce reliable knowledge of a system's functioning. If adaptive management is to guide similar projects in the future, the project should develop a conceptual model with defined management objectives, a set of explicit hypothesized outcomes, management activities and a monitoring scheme to allow the hypotheses to be tested, and a reevaluation of the project in light of what was learned.

Roger Leventhal's comments

The use of dredged sediments needs to be made on a site specific basis. Roger did not believe a general rule can be made from one project. There are complications from using dredged sediments that need to be planned for including 1) drying and hardening of muds into resistant layers, 2) setting up of sandy and gravel sediments into hardened areas that impact channel formation, 3) excessive expansion of sediments due to dispersal of fine grained saline muds pumped with fresher water and several other issues.

The resistivity staffs as used by the Hamilton project were of little value. They are very complicated and subject to error due to mixing of saline and fresh water. Also conducting a direct measurement should always be preferable to an indirect measurement.

Roger would like to see more specific measurements (specifically width to depth measurements) of the channels including the outboard channel, and then compare those measurements to nearby marshes like Petaluma Marsh—to help find a relationship between channel morphology/ area and peninsula presence. PWA is making claims that the outboard channel will approach full equilibrium late in the decade based on recent measurements of channel area approaching the equilibrium area (see PWA plots). However, if the width-to-depth ratios are not in balance due to resistant sill layers or the erosion resistance of the marsh peats, then the projection that equilibrium conditions will be met in the future may not happen. This applies to internal channels, also. It is possible that internal sills and/or the peninsulas may result in a modified channel morphology or reduced density that produces channels that are not useful for clapper rails.

Stuart Siegel's comments

Stuart noted performance criteria for *restoration projects* should reflect (1) our understanding of processes that control marsh evolution from baseline to target equilibrium or "mature" conditions, (2) the specific magnitudes and natures of those processes at a particular restoration site, and (3) how our designs interact with these processes. In other words, they define our *expectations*. Therefore, when performance criteria are not being met, our response should be to ask and answer three key questions:

(1) Is something wrong and if so should we take corrective measures?
(2) Is there a problem with our original expectations including the bases upon which we built those expectations and if so should we adjust our expectations including examining those underlying bases?
(3) Are the resources being adversely affected or merely not beneficially aided at least within a reasonable time frame?

At Sonoma Baylands, Stuart felt there is a mix of real problems (some erosion sills and peninsulas remaining longer than desired) and a mismatch between expectations and outcomes (severe lag in evolution schedule). Yet there exists reasonable concurrence that the site is serving shorebirds and waterfowl well (not part of its intended outcomes though good nonetheless) but not yet serving its target rail and mouse populations.

Stuart felt the appropriate consideration for the project's performance criteria is to place real examination of whether the sill and peninsula problems should be actively addressed

(adaptive management) and to update our expectations of marsh evolution *from here forward* given what we now know and should know (via filling data gaps addressed above), then monitor for meeting those revised criteria.

From *lessons learned* for other restoration projects, it is important that the original expectations be tracked forward and discussed in context of actual outcomes, with our best professional judgment combined with all the monitoring data to *explain* why those expectations were not met and thereby use that new insight in design of and performance criteria for future projects.

Relative to specific performance criteria at Sonoma Baylands, Stuart suggested that the original criterion on channel density (match the outboard marsh) be updated to provide a density reflective of historic marshes in the vicinity (see old T-Sheets), as centennial outboard marshes such as at Sonoma Baylands are well known to have lower channel density than the Holocene tidal marshes in the estuary. Higher channel density benefits clapper rails.

The monitoring plan should reflect a shift over time from physical monitoring to biological monitoring, with scheduling based on site evolution conditions. Right now, data should be gathered on biological colonization with select ongoing physical process measurements (tidal exchange, elevation, channel network formation, perimeter levee erosion).

As a general rule, restoration should be first, and science second. If the ecological goals are not being met, then we should intervene. Intervening for the sake of science is fine so long as it does not adversely impact the resources targeted by the restoration.

Lastly, performance criteria and monitoring activities need to consider the relationship between various processes and outcomes. For example, water quality affects several biological functions. Performance criteria should provide for the minimum levels in water quality parameters that affect those functions – e.g., salinity, temperature, dissolved oxygen – and monitoring should allow for identifying problem areas so that solutions can be developed. Because problem areas generally cannot be known in advance, the monitoring should be flexible to shift resources where and when problems do occur (i.e., adaptive management).

3. Peninsulas

Josh Collins's comments

What have they achieved, what (if anything) should be done to adjust them, and can the monitoring answer the question? Josh didn't see that it can. The comparison (with and without peninsulas) is a modeling outcome without empirical testing.

The peninsulas were an experiment with no real control, either in terms of sedimentation, erosion control, or predator access (the three main concerns) and thus tell us little about their efficacy. These are expensive features about which we have learned little.

One lesson to take away is that such experimental features should be acknowledged as such in the beginning, and projects should be designed to test such experimental features, perhaps by using them in some areas but not everywhere.

Josh saw the need to be careful about post-processing the data to try to test the past effects of the peninsulas – that is not the same thing as designing a test in the first place. He acknowledged very little ability to post-classify data between cause and effect. This makes transferring "lessons" from Sonoma baylands to other projects, such as Hamilton, an uncertain proposition.

With regard to predator control, Josh suggested following the advice of the experienced animal control people. But he expected they're going to say break up the peninsulas (don't have to lower them) and disconnect them from the levee.

Tom Kucera's comments

Tom felt peninsulas should be addressed if undesirable carnivores invade and prove to be a problem. Also, more animal data are needed than just incidental data. The appropriateness of the topographic relief provided by the peninsulas in a marsh plain needs discussion. Incidental observations on animal occurrence are no substitute for more systematically and rigorously collected data.

Roger Leventhal's comments

The internal channel development, especially channel density, will be one good parameter to measure the impact of the peninsulas on the marsh evolution. It appears from early data that we have areas with incomplete channel formation (permanent mudflats) but perhaps it is too early to draw conclusions.

Roger suggested modifying the peninsula design to look at other ways of achieving the same goal with different means and especially an approach with a smaller footprint. Right now there is only one design type.

Roger noted sediment settling tests aren't comprehensive in their considerations; geotechnical analysis counted on much more subsidence, yet the peninsulas seemed to be maintained by buoyancy. Therefore, the assumption that the peninsulas will subside following restoration may not be correct.

Suggests looking at peninsulas since they are such a hot topic; explore having a lesser footprint.

Stuart Siegel's comments

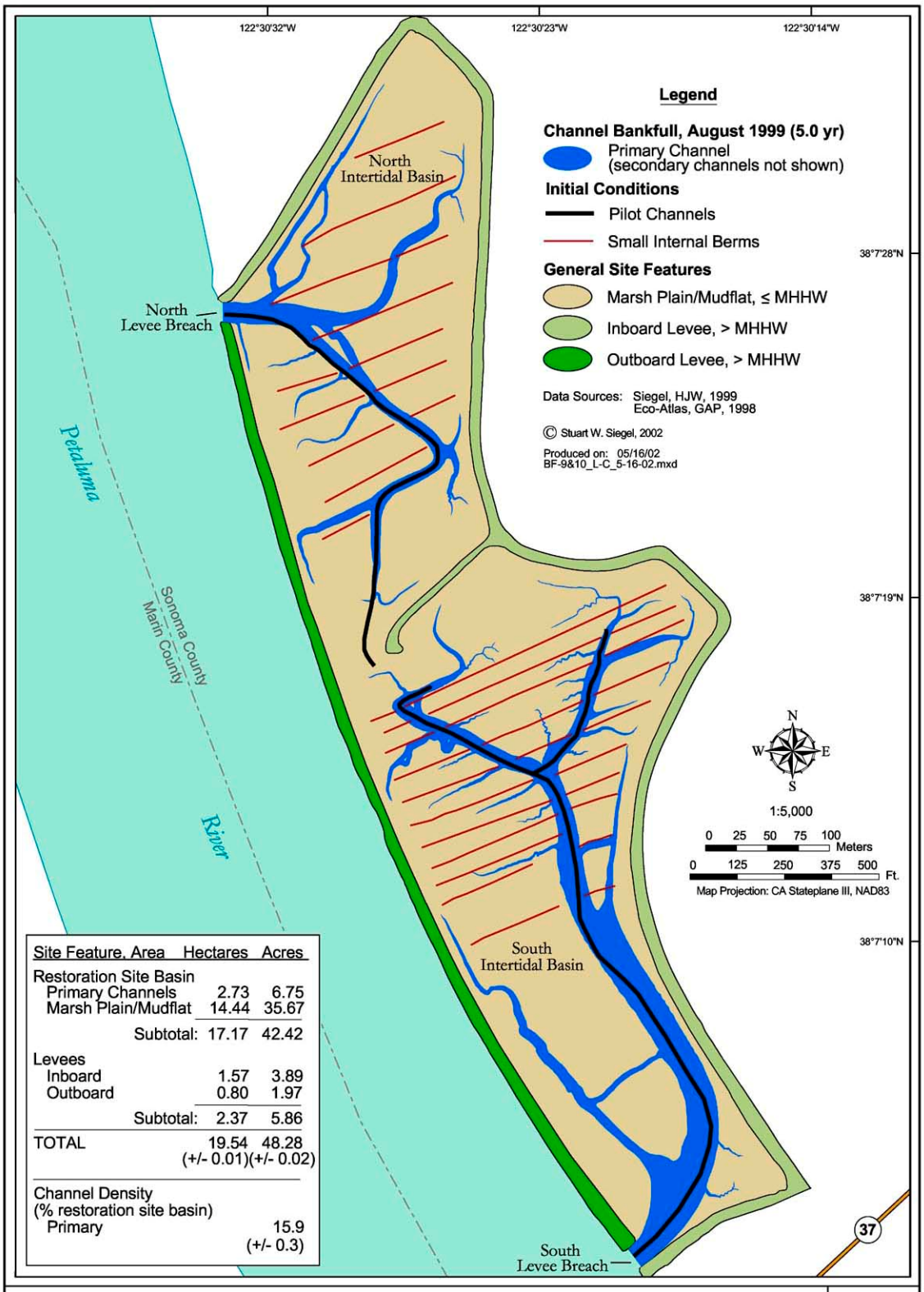
Stuart suggested peninsulas should be moved away from levees in all locations to minimize predator access into the marsh.

The extent to which the peninsulas continue to protect the inboard levee from erosion needs to be established definitively if it is to be used as an argument for not lowering the peninsulas. The toe of much of the inboard levee is now vegetated which provides some energy reduction. The site drains on low tide so the percent total time of standing water against the inboard levee is lower than when the site experienced prolonged submersion. Because of the adverse biological effects of the peninsulas, they should be lowered unless their erosion protection function remains important.

Stuart noted that the one "peninsula" at Carl's Marsh – the levee providing access to the PG&E tower in the center of the site, eroded initially before vegetation colonization but within a few years when plants established (alkali bulrush and Pacific cordgrass), no further erosion took place even during major storm events.

Stuart also noted the major positive channel formation effect of the "non-engineered" peninsulas at Carl's Marsh. These linear and parallel dirt and vegetation piles – about 3ft tall (putting them around mean tide level) and 6ft wide – came about from clearing the farm field to get borrow soils for the inboard levee and covered only parts of the site. Over time these piles were entirely buried by sedimentation and fully disappeared. Each parallel pair created a mini-watershed and within each watershed a channel formed, most of which remain to this day and leading to a high channel density in a small restoration site. Most importantly, areas that did not have these piles had significantly lower channel densities (roughly half the areal density).

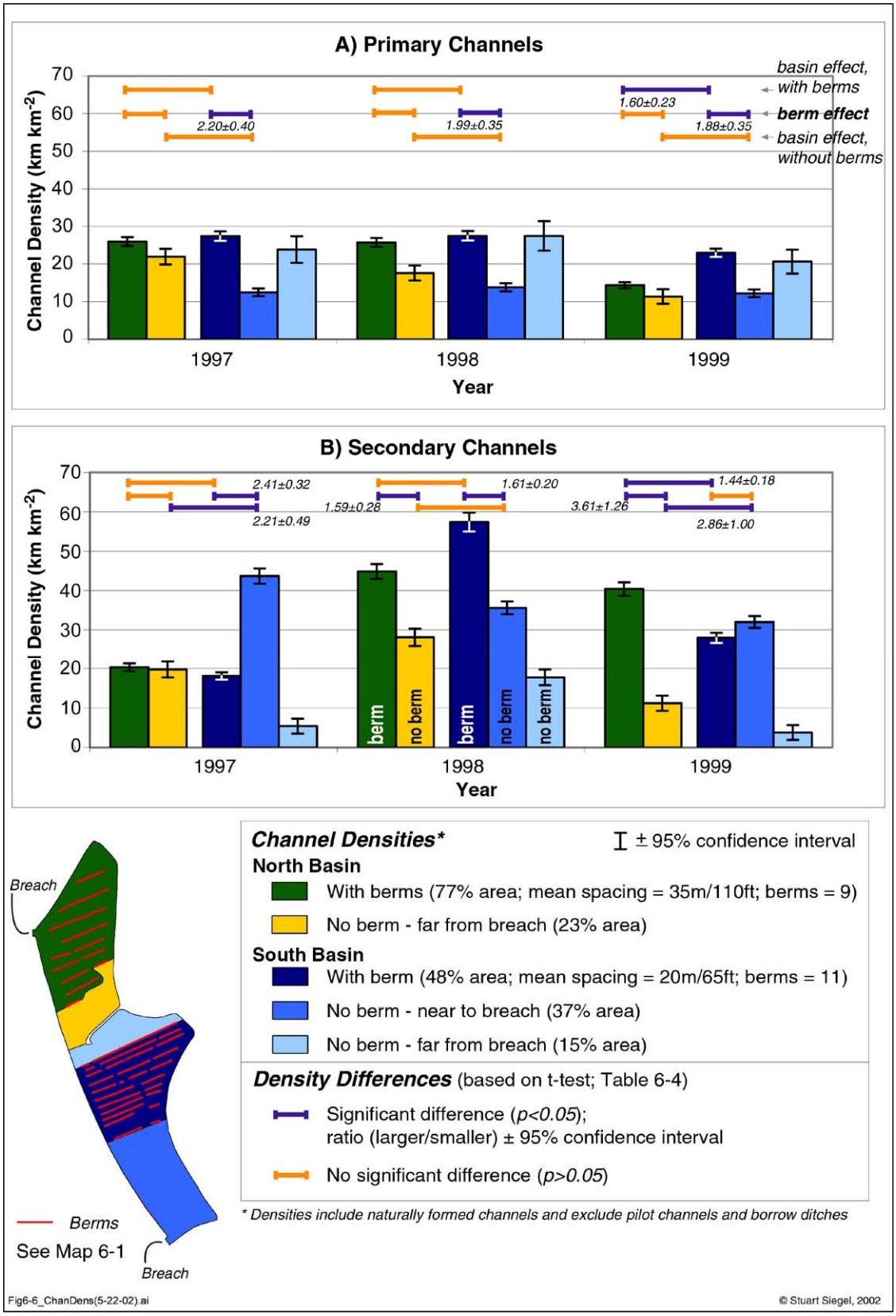
The key lesson learned from Carl's Marsh is that small, non-engineered, non-invasive, non-lasting "structures" can have a longer term, positive effect on reaching desirable outcomes – in this case, channel habitats for California clapper rails which are now nesting at the site. Stuart included two figures to illustrate these points clearly (Siegel 2002). The map (labeled Figure 6-1C) shows the spatial relationship between the berms and the naturally formed channels 5 years after restoration and the figure shows the channel density data at that time (plus two prior years). The key items to note on these two figures are (1) there is an effect on spacing of the berms (too far apart = little or no effect), (2) there is an effect with distance from the breach and/or orientation relative to flows through the (the farther away = more effect), (3) focus on the "primary" channels which are the larger, more ecologically significant channels.



Site Feature, Area	Hectares	Acres
Restoration Site Basin		
Primary Channels	2.73	6.75
Marsh Plain/Mudflat	14.44	35.67
Subtotal:	17.17	42.42
Levees		
Inboard	1.57	3.89
Outboard	0.80	1.97
Subtotal:	2.37	5.86
TOTAL	19.54 (+/- 0.01)	48.28 (+/- 0.02)
Channel Density (% restoration site basin)		
Primary	15.9 (+/- 0.3)	

Primary Channel Bankfull with Initial Conditions, 1999
Petaluma River Marsh, Sonoma County, California

Map 6-1C


A) Primary Channels
Channel Density (km km-2)
70
60
50
40
30
20
10
0
2.20±0.40
1.99±0.35
1.60±0.23
1.88±0.35
basin effect, with berms
berm effect
basin effect, without berms
1997
1998
1999
Year
B) Secondary Channels
Channel Density (km km-2)
2.41±0.32
2.21±0.49
1.59±0.28
1.61±0.20
3.61±1.26
1.44±0.18
2.86±1.00
berm
no berm
berm
no berm
no berm
1997
1998
1999
Year
Breach
Berms
See Map 6-1
Breach
Channel Densities*
± 95% confidence interval
North Basin
With berms (77% area; mean spacing = 35m/110ft; berms = 9)
No berm - far from breach (23% area)
South Basin
With berm (48% area; mean spacing = 20m/65ft; berms = 11)
No berm - near to breach (37% area)
No berm - far from breach (15% area)
Density Differences (based on t-test; Table 6-4)
Significant difference (p<0.05);
ratio (larger/smaller) ± 95% confidence interval
No significant difference (p>0.05)
* Densities include naturally formed channels and exclude pilot channels and borrow ditches
Fig6-6_ChanDens(5-22-02).ai
© Stuart Siegel, 2002

Phil Williams added the following

PWA has already anecdotal experiences from this project have resulted in changes to the Hamilton project, such as, longer fetch-length to ensure that wind-wave action doesn't create permanent mudflat habitat. This presents an opportunity: The Hamilton Project can still be altered based on conclusions made about Sonoma Baylands. The current Hamilton design still has some peninsulas at a spacing of 1,500 feet. Recommend reviewing the design and perhaps revising per the recommendations of this memo.

4. Sills

John Callaway's comments

John suggested applying experimental ideas to sills in the pilot unit before making changes in the main unit.

Josh Collins' comments

The process as originally described is in fact happening. But it is taking longer than predicted (the slope of the trajectory is lower than hoped for). That is not a problem unless policy makers say it's a problem.

It would be good to know what causes the sill to be so resistant. Do we have data showing that spring tides don't reach the marsh plain? Can we find out if dredged sediment is actually the cause? If the outboard plain is really so high, then it is unusual and not a very good analogue for the project endpoint.

Josh noted that the underlying peat may be separating from the lower bay muds and floating upwards, elevating the sill as it is incised (Josh suggested Roger could speak to this topic better than he). Has anyone simply cored all the way through the sill to the stiff bay muds, to see what is happening at depth?

Tom Kucera's comments

Tom suggests developing a means of testing and rejecting that hypothesis.

Roger Leventhal's comments

Roger felt the project team is monitoring water levels correctly, the data is still inconclusive as to if the sills will erode completely. He felt if the water level heights and tidal inundation-frequency do not continue to improve on trajectory then remedial action should be taken.

He noted that the setting up and hardening of the dredged material could also cause other sills, and that should be investigated.

Stuart Siegel's comments

Stuart supports eliminating the sills if they are an impediment to promoting channel density and complexity and suggests coring the sills to determine their character and thus whether natural erosion likely to erode in the near future. He also suggests determining whether these sills are in the deposited dredged material or the underlying farm field as such information directly informs remedial measures as well as contributions toward design of other restoration sites.

5. Experimental Approaches

John Callaway's comments

Regarding experimenting with the sills, experiments probably needs to be more specific to be testable -- a specific time-frame would bracket things so that we would have a predetermined point to come back and test. Plus we probably also need to more specific about the extent of erosion -- will it be the exact same tidal range as outside the channel or some lower threshold?

John questioned whether we really know enough to say that marshes do not need to be planted and that we should just rely on natural colonization of restored marshes. John suggested an experimental study that would take advantage of the cells within the marsh due to the peninsulas and islands: planting different species in different cells and measuring species diversity over time to see if planting is appropriate or is not needed.

In order to rigorously test something (with any statistical analysis), you need replication of treatments. While this project was not designed with this sort of approach in mind, it presents opportunities to test ideas in one unit at a time; it would be worthwhile to try various treatments in different units of the marsh (with replicates where possible) in order to test for benefits from particular treatments. This would allow us to begin to show real cause-effect links between management approaches/treatments and benefits. Without more specific design like this it will be very difficult to understand why certain processes are or are not occurring.

Tom Kucera's comments

Tom felt a beneficial approach may be to define the potential problems (e.g., lack of sedimentation; source of weeds; provision of upland refugia for undesirables), and remove some of the peninsulas to test if such problems are lessened.

Tom overall noted that systematic analysis should be applied to all situations, and suggested avoiding relying heavily on anecdotal and incidental data. Such information should not be ignored, but should not substitute for more rigorously collected, reliable, and targeted data.

Phil Lebednik's comments

1) Site-specific characteristics that would influence the outcome of the project were not fully taken into account. For example, there was an assumption that certain tidal prisms would occur during a certain time frame, which didn't occur. Although the original estimate may have been theoretically sound, there were site-specific characteristics that prevented the expected result.

2) A monitoring plan is needed to tell you what you don't know. Four primary components that should be addressed in the monitoring plan: the overall purpose should be met in the monitoring plan (learn and apply general lessons to other restoration projects); Monitoring Plan should be consistent with the conceptual model and design from 1989; site specific characteristics should be taken into account; and, information gathering should allow for alternative results (success criteria has been predicated on predictions coming true, and predictions didn't come true in the time frame, so are there alternative ways of monitoring to account for unexpected results)

It is important to take an experimental design approach using controls to reduce the influence of biased expectations. Otherwise you risk missing events or results that were not expected to occur. In order to discover the environmental processes that are occurring, a self-testing design with a null and alternative hypothesis should be in place. Ecological restoration is not yet an exact science; therefore, it is critical for future improvement of this practice that we learn as much as possible from each project. Employing a monitoring methodology that is not scientifically robust risks the generation of "conclusions" that are invalid. Such false premises, if applied to future projects, may result in limited success or failure that could have been avoided. We cannot afford to squander the limited financial resources available for future restoration by failing to learn correctly the lessons that each project can teach us.

Nadav Nur

Taking an experimental approach to peninsulas would provide good learning opportunities.

Stuart Siegel

Stuart's first question is: experimental approach to what? The site does lend itself to ongoing small-scale experiments appropriate to its current and future conditions, such as some planting experiments or sill removal or small channel formation experiments. If any such experiments are considered, they should be predicated upon a conceptual model, with stated hypotheses, with clearly measurable outcomes, include a monitoring element to ensure the data are collected and evaluated in a timely manner, and ensure coordination with any other parties that may modify the site so as to avoid interferences.

The site already provides an experiment regarding the peninsulas – though not controlled, replicated, nor set up with a conceptual model, hypothesis, etc. Highly recommend gaining the "lessons learned" from this design element via the approach described above under Data Gaps.

6. <u>Additional comments from meeting attendees</u>

Peter Baye

Peter suggests that the sill may be a knick point or hydraulic jump, suggesting a reoccurrence of another sill appearing as the channels potentially braid and fan out. Peter cautioned against eliminating the sill before getting more data on the underlying Early Holocene peat material, such as its shear strength, erodibility, and composition.

Peter suggests that predators are already keyed in to the presence of prey on the site. He discouraged ignoring existing data just because it wasn't gathered in relation to the monitoring plan (animal sightings?). Starting from scratch would be more detrimental than using that data. He suggests broadening what is in the monitoring plan, and making it more adaptive, so that decisions for remedial actions can be made with more confidence.

Peter suggests using indirect data collection as a quick, easy, and cost effective alternative to gathering vertebrate data, such looking for animal tracks and dung.

Peter also provided post-meeting comments in a memorandum, which is Attachment C in this document.

Andree Breaux

Andree suggested requiring native vegetation as part of that success criterion since the cost of eradicating invasive non-natives can be enormous.

Marilyn Latta

Marilyn encouraged engaging volunteers in monitoring projects.

Jim McGrath

Jim felt internal circulation was unclear. The tidal prism and sedimentation was less than expected over 9 years. The marsh might have been lower than they thought it was, and the channels did not enlarge for several years. He suggested taking forward issue: Too much or too little sediment in the marsh? He proposed analyzing sediments linked to mercury. Regarding monitoring, measurements are needed of inundation at low tide.

Unless peninsulas are dry enough for denning, let them go.

Anitra Pawley

Anitra encouraged university involvement and scientific studies and suggested that invertebrate studies continue due to lack of existing info on invertebrates in the Bay.

Barbara Salzman

Monitoring costs: The money is going down for monitoring unless things change. Don't set fiscally unattainable standard.

Carl Wilcox

Agencies require building in upland transitions, even though these habitats were not historically present on site. Levees exist unnaturally in these projects and give predators access to sensitive prey. Recommends caution in incorporating these features into historical marsh areas where rails are trying to be encouraged. When rails move in, predators will be a bigger problem. He was concerned the levees are not eroding as they were designed to. He suggested building them to lower elevations.

Invertebrate sampling is expensive, and birds are a better indicator.

5. Disclaimers:

a. The recommendations of the review team are not binding on any permitting agency and they will not restrict any agency's authority.

b. The Wetlands Restoration Program's Wetlands Monitoring Group makes every effort to provide guidance; we cannot guarantee issuance of permits by any regulatory agency.

c. The Wetlands Restoration Program's Wetlands Monitoring Group intends to provide comments and feedback on monitoring plans and designs. This assistance will necessarily be limited, and should not be expected to substitute for professionally prepared site evaluations, hydrological studies, final designs, and construction plans.

d. The Restoration Program and the participating agencies will not be liable for the failure of any project.

e. Project review by the Wetlands Monitoring Group does not constitute an endorsement of the project by the Wetlands Monitoring Group or by the Wetlands Restoration Program.

6. References

Jackson, N.L., D.P. Horn, V. Spalding, and K.F. Nordstrom. 1999. Changes in beach water table elevation during neap and spring tides on a sandy estuarine beach, Delaware Bay, New Jersey. Estuaries 22: 753-762.

Siegel, S.W. 2002. Slough channel network and marsh plain morphodynamics in a rapidly accreting tidal marsh restoration on diked, subsided Baylands, San Francisco Estuary, California. Ph.D. dissertation, U.C. Berkeley, Berkeley, California.

ATTACHMENT A

Sonoma Baylands Wetlands Demonstration Project

1996 Monitoring Plan

Summary of Monitoring Program and Schedule

SUMMARY OF MONITORING PROGRAM

PHYSICAL ATTRIBUTE	MEASUREMENT	SCHEDULE
Dredged Material Fill Elevations	Resistivity staff readings	**Year 0:** Monthly - Both units **Year 1:** Monthly - Main Unit
	Elevation transects	**Year 0:** Pilot Unit
	Photogrammetric surveys	**Year 1:** Main Unit (Approx. 1 month after levee breach.)
Chemical Constituents	Laboratory testing	**Year 0:** Main Unit
Exterior Tidal Channels	Channel cross-section surveys	**Year 0:** Establish cross-sections prior to levee breaches. Resurvey Pilot Unit 6 months after levee breach. **Years 1 - 5:** Resurvey both units semi-annually in March and September. **Years 6+:** Resurvey annually in Spring until no significant increase in dimensions, then every fifth year.
Tidal Regime	Tide elevations	**Year 0:** Pilot Unit 6 months after levee breach. **Year 1 - 5:** Both units semi-annually in March and September. **Years 6+:** Annually in Spring.
Peninsula Crest Elevations	Level line surveys	**Year 5:** Preliminary survey **Year 10:** Complete survey
Tidal Sedimentation	Resistivity staff readings	**Year 1:** Monthly **Years 2 - 5:** Quarterly **Years 6+:** Annually in Summer until no significant change.
	Elevation transects	**Years 1 - 10:** Annually in Summer **Years 11+:** Biennially in Summer until no significant change.

PHYSICAL ATTRIBUTE	MEASUREMENT	SCHEDULE
Internal Channel Development	Mapping from aerial photography	**Years 1 - 10:** Annually in Summer **Years 11+:** Biennially in Summer until no significant change.
	Elevation transects	**Years 1 - 10:** Annually in Summer **Years 11+:** Biennially in Summer until no significant change.
Water Quality	Field testing of salinity, temperature, and dissolved oxygen	**Year 0:** Biweekly - Pilot Unit **Year 1:** Biweekly - Main Unit
BIOLOGICAL ATTRIBUTE	**MEASUREMENT**	**SCHEDULE**
Marsh Vegetation Establishment	Field survey	**Years 0+:** Semi-Ann. - Pilot Unit **Years 1+:** Semi-Annually until cover sufficient for aerial mapping.
Marsh Vegetation Cover	Mapping from aerial photography	**Years 1 - 10:** Annually in Summer **Years 11+:** Biennially in Summer
	Vegetation transects	
Birds	Census unvegetated areas from perimeter levees. Sample vegetated areas with transects along levees and peninsulas. Census/sample reference areas.	**Year 0 - 1:** 14 surveys/year in Pilot and Main Units. **Years 3+:** Biennially until success criterion is met. 14 surveys/year prior to vegetation. 18 surveys/year subsequently.
Fishes	Seine/trawl and enumerate species following restoration of tidal action.	**Year 0:** Monthly from Jan - Apr in Pilot Unit. **Year 1:** Monthly from Jan - Apr in Main Unit.
	Seine channels at site and reference marsh and enumerate species.	**Years 3+:** Biennially in March and September until success criterion is met.
Endangered Species	Map suitable/potential habitat.	**Years 5+:** Survey every fifth year.
	Call surveys for California clapper rail in suitable/potential habitat. Live trapping surveys for salt marsh harvest mouse in suitable/potential habitat.	
Benthic Macroinvertebrate Colonization	Sieve sediment cores and enumerate species in Pilot Unit.	**Years 0 - 4:** Semi-annually in March and September.

NOTES:

Year 0 will end and Year 1 will begin upon the restoration of tidal action to the Main Unit, which is expected to occur in October 1996.

Restoration of tidal action to the Pilot Unit occurred during Year 0 on January 24, 1996.

Except as specifically noted, monitoring will continue until the monitoring results indicate that all of the success criteria have been met.

ATTACHMENT B

Sonoma Baylands Wetlands Demonstration Project

Draft Memorandum from Phillip Williams and Associates to Eric Joliffe, U.S. Army Corps of Engineers, regarding Analysis of Sonoma Baylands Evolution from 1996 to 2003 and Recommendations for Management Actions, August 12, 2004

Status of Physical and Biological Success Criteria

limiting factor in sedimentation rates at Sonoma Baylands. In the Pilot unit, significant sediment deposition did not begin until 2000 when the diurnal tidal range increased to about 1 foot. Since 2000, annual sediment deposition has averaged 0.2 ft/year. In the Main Unit, sediment deposition has not kept up with subsidence at the site due to the limited tidal prism; however, the diurnal tidal range is now about 1 foot, and we anticipate sediment deposition to increase to the rates observed in the Pilot Unit or about 0.2 ft/year. Over the long-term, these rates of sedimentation will decrease exponentially as the internal marshplain approaches MHHW.

3.3 TIME LAG OF VEGETATION COLONIZATION

As discussed in Section 2.3, cordgrass colonization at Sonoma Baylands has been concentrated along the fringe of the site, expanding into the site via rhizome expansion. Colonization of the mudflats has been hampered by the muted internal tides, overly saturated soils, and potentially anoxic conditions in surface soils. However, conditions are anticipated to improve with increased drainage in the near future for colonization of the mudflats, particularly in the Pilot unit where 12 individual pioneer 'sprigs' were identified on the mudflat in September 2003. While the tidal asymmetries may likely not completely disappear until 2009 and 2007 in the Pilot and Main Unit, respectively, increases in internal elevations and improvements in drainage should provide adequate conditions for vegetation colonization across the majority of the site within 10 to 20 years. In addition, initial tidal monitoring results from the spring of 2004 show significant reduction in tidal asymmetries in both units, suggesting that the outboard channels are eroding faster than predicted in Section 3.1.

4. EVALUATION OF SUCCESS CRITERIA

To assess the need for adaptive management action at Sonoma Baylands, we review project's success criteria and evaluate whether the success criteria have been achieved or will likely be achieved within the originally planned time frame (Table 4).

Table 4. Status of Physical and Biological Success Criteria

Success Criterion	Criteria	Criteria Achieved?	Status (as of September 2003)
Physical Criterion No. 1	*The maximum dredged material surface elevation in each unit approximately one month after tidal action is restored will not exceed +2.9 feet NGVD (excluding levee and*	Yes	1996 monitoring report confirmed that dredge material was below +2.9 feet NGVD.

	peninsula material).		
Physical Criterion No.2	*Prior to the restoration of tidal action to the main unit, concentrations of chemical constituents in the surface dredged material of the main unit will not exceed RWQCB requirements.*	Yes	
Physical Criterion No.3	*The primary tidal channel between each bayfront levee breach and San Pablo Bay will measurably erode toward the equilibrium channel geometry within 1 year of excavation of the levee breach.*	Yes	Tidal channels have been eroding since breaching, but at a slower rate than initially anticipated. Channel erosion since 2000 has been increasingly rapid.
Physical Criterion No.4	*Within 5 years, the mean tide range in the primary channel within each unit near the levee breach will be at least 90% of the mean tide range in northern San Pablo Bay.*	No	As of September 2003, Pilot Unit mean tide range was 62% of open Bay, while Main Unit mean tide range was 20% of open Bay.
Physical Criterion No.5	*At least 90% of the total length of the peninsulas will have a crest elevation below +4.0 ft NGVD, & all portions of the peninsulas more than 25 ft from the peripheral levees will have crest elevations below +4.5 ft NGVD, within 10 years.*	No	Crest elevations range from +4.6 ft to +5.46 ft NGVD. Due to the damped interior tidal range, the peninsulas still provide upland habitat for terrestrial burrows.
Physical Criterion No.6	*Within 20 yeas, the density of tidal channels within the restored marsh will equal or exceed the*	Premature to judge	

	pre-project density of natural in the existing bayward marsh.		
Biological Criterion No.1	*Tidal marsh vegetation will begin to establish in each unit within 5 years.*	Yes	Cordgrass colonization has been concentrated along the perimeter areas and some peninsulas. However, cordgrass sprigs identified on mudflat of Pilot unit in 9/03.
Biological Criterion No.2	*At least 65% of the entire tidal area will have marsh vegetation cover within 20 years.*	Premature to judge	
Biological Criterion No.3	*The total density of shorebirds, waterfowl, and other waterbirds will not be significantly less than the corresponding densities for reference sites within 20 years.*	Premature to judge	Shorebird density is higher than at reference sites.
Biological Criterion No.4	*Estuarine fishes and their life stages will utilize tidal channels within the restored tidal area in total densities that are not significantly less than those of nearby reference marshes within 20 years.*	Premature to judge	
Biological Criterion No.5	*The project site will support a minimum of three pairs of California clapper rails within 20 years.*	Premature to judge	
Biological Criterion No.6	*The project site will provide a minimum of 28 acres of suitable habitat for the salt marsh harvest*	Premature to judge	

	mouse within 20 years.		

5. FUTURE MANAGEMENT ACTIONS

5.1 POTENTIAL ADAPTIVE MANAGEMENT ACTIONS

In the spring of 2004, there appeared to be a significant acceleration in improvements to tidal drainage and potential seedling habitat, particularly in the Pilot Unit. Smaller order dendritic tidal channels in the Pilot unit have incised significantly, and spread laterally, draining much of previously overly saturated mudflats. Baye (2004) reports that initial cordgrass shoot heights along the site periphery seem to be responding to increased drainage of the flats and are closer to the height of natural creek bank cordgrass. Baye (2004) concludes that the mudflats are now providing suitable seedbed conditions for widespread rapid recruitment of cordgrass and probably direct colonization of picklweed. The dramatic improvements in conditions for vegetation colonization suggest major adaptive management actions are not warranted at this time. Below, we discuss two potential actions, lowering internal peninsulas and removing the slough channel sills.

5.1.1 Lower wind-wave peninsulas

In the Main Unit, the over filled wind-wave peninsulas in conjunction with the muted tides have provided access and dening habitat for predatory animals such as the red fox. It was anticipated that peninsulas with crest elevations at or below +4.5 feet NGVD would not provide sufficient dry soil for the excavation of burrows by terrestrial animals (Monitoring Plan, 1996). As of 2001 (the time of last crest elevation survey), the average peninsula crest elevation was +5 feet NGVD. At that time, the maximum high tide elevations in the Main Unit were only +2 feet NGVD. However, tidal data from 2004 indicates that spring tidal elevations in the Main Unit regularly reach +3.5 feet NGVD (Figure 25), and we expect spring tide elevations to increase to +4 feet NGVD by 2007. At that time, tidal conditions should prevent burrowing in the peninsulas. Moreover, as the tidal levels increase, the peninsulas' role in reducing fetch lengths for wind-wave generation become important to protect the inboard levee from erosion. Therefore, we do not recommend lowering the peninsulas at this time.

Avocet Research has recommended excavation of peninsula 5 in the Main Unit to disconnect it from the inboard levee, limit predator access, and encourage colonization by Caspian terns as has been observed on sections of peninsulas 8 and 14 (Figure 26). This could be accomplished relatively easily with a long-arm excavator accessing the north end of peninsula 5 from the inboard levee.

5.1.2 Remove internal sills

The sills apparent along the main channel thalwegs of the Pilot and Main units interior of the breaches have slowed evolution of the interior channel network, retarded drainage of the mudflats, and prolonged the time to reach conditions suitable for vegetation colonization of the mudflats. The Main Unit sill appears to be only about 25 feet wide, and given the large tidal prism, we expect that it will erode naturally in about a year or less (Figure 17). The Pilot Unit sill is more substantial, approximately 75 to 100 feet wide. As a result of the smaller tidal prism, the sill will likely persist for another 2 to 3 years and continue to impede evolution of the tidal drainage network. However, most of the adverse impacts associated with the sill have already occurred by slowing evolution of the drainage network over the last 5 years. With the improvements in drainage and colonization conditions, it is not clear what the future impact of the sill will be on vegetation colonization. To accelerate the erosion of the sill, we recommend loosening the upper 2 feet of soil to a depth of -3 feet NGVD. The soil could be loosened by using hand tools or small discharge explosives.

5.2 REVISIONS TO MONITORING PROGRAM

The field monitoring of Sonoma Baylands from 1996 to the present has been an intensive data collection effort designed to track the evolution of the site and to monitor the status of the project in meeting the success criteria (USACE and SCC, 1996). Given the understanding of the evolution of the site to date, there is an opportunity to refine the current monitoring plan to improve its effectiveness in monitoring the site's evolution into the future.

We recommend that the following changes be made to the current monitoring plan:

- Reduce outboard channel monitoring to one cross-section per unit—XS-1 in the Pilot Unit and XS-13 in the Main Unit (Figure 4)—to insure erosion of outboard channels continues towards a balance with tidal prism.
- Monitor one internal cross-section in each unit to track the rate of internal sedimentation.
- Monitor the channel thalweg elevations to insure no erosion resistant surface is encountered that could impede evolution of the site.
- Monitoring the tidal regime simultaneously in the Pilot Unit, Main Unit, and at the Petaluma River railroad bridge over one 28-day period per year to insure a full tidal signal is achieved and tidal asymmetries disappear.
- Monitor crest elevations of internal peninsulas every 3 years to insure peninsulas subside to +4 feet NGVD or below to deter burrowing and access by predatory animals.
- Begin using annual aerial photographs to quantify vegetation coverage in the units.
- Occupy one vegetation transect per unit per year to track the elevation of vegetation colonization.
- Maintain annual interior photo documentation at established stations.
- Discontinue benthic surveys, but continue annual bird and fish surveys.

ATTACHMENT C

San Francisco Bay Area Wetlands Restoration Program
Conflict of Interest Statement

The San Francisco Bay Area Wetlands Restoration Program Wetlands Monitoring Group (the Group) attempts to have those reviewers who participate as members of the Group avoid any conflict of interest. Conflict of interest, as it relates to the Group, is distinguished into two categories: financial and personal/institutional. The two distinct types of conflict of interest warrant two distinct courses of action of the part of each Group member. All those members having a *financial* conflict of interest with a project will NOT be allowed to evaluate proposals for which they have a financial connection and/or provide guidance and comment on that project, without exception. However, those Group members having a *personal/institutional* conflict of interest are required only to disclose any relationship, yet are not disallowed from project review and comment.

Regardless of the type of conflict of interest, each Group member has the personal obligation to avoid a conflict as well as the personal obligation to disclose any such conflict, whether real or apparent, to the Group as a whole.

Financial Conflict of Interest. The Wetlands Restoration Program expects that Group members will not review proposals in whose development they have assisted or if they would receive a financial benefit from the funded project. A conflict of interest would be considered to exist whenever a member of the Group **or** a relative of a Group member (including, for instance, a spouse, sibling, parent or child) has a personal, material, or financial interest in a transaction or project under consideration by the Group.

Personal/Institutional Conflict of Interest. If a Group member has a personal or institutional connection with a project sponsor in any way, but there is no conflict of interest, the member will be allowed to participate in the project review provided that any connection is disclosed prior to project review. A personal connection with a project sponsor is considered worthy of disclosure if any of the following relationships were applicable during the **past four years**: collaboration on research, pilot, or implementation proposal or project; co-authorship; thesis or postdoctoral advisorship; and/or supervisor/employee relationship. An institutional connection – such as between employers and their employees – will be considered worthy of disclosure. For example, an employee of a state or federal agency is considered to have an institutional connection with a proposal submitted by that agency, even if the project sponsor is in a different division of the agency than the reviewing Group member. Similarly, a university faculty member is considered to have an institutional connection with a proposal submitted by that university, even if the applicant is in a different department of that university campus.

To avoid any problems with conflict of interest or appearance of bias, scientific and technical reviewers are expected to review proposals independently and without delegating the review task in whole or in part to any other person. Any efforts to delegate review will be considered a conflict of interest.